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## Industrial automation systems and integration — Integration of industrial data for exchange, access, and sharing — Part 1: Architecture overview and description

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### ABSTRACT:

This document provides an overview and description of the ISO 18876 architecture for integration of industrial data.

### KEYWORDS:

industrial data, integration, exchange, access, sharing, architecture, overview

### COMMENTS TO READER:

This draft is intended for review by WG10, as a final draft prior to release for CD ballot.

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## Contents

Page

1	Scope .....	1
2	Normative references.....	1
3	Terms and definitions .....	2
4	Organization of ISO 18876.....	3
5	Model integration .....	4
5.1	Integration models .....	4
5.1.1	Principles .....	4
5.1.2	Integration model concepts .....	5
5.1.3	A Full Integration Model .....	5
5.2	Overview of the integration process .....	6
5.3	Standards organization .....	<b>Error! Bookmark not defined.</b>
6	Data mapping and consolidation.....	10
7	Relationship to other standards.....	11
	Annex A (normative) Information object registration.....	12
	Bibliography .....	13
	Index .....	14

## Figures

Figure 1 – Model Integration.....	4
Figure 2 – Primitive Concepts .....	5
Figure 3 – A full integration model .....	6
Figure 4 – Integrating and application model with an integration model.....	7
Figure 5 – Analyzing the application model .....	7
Figure 6 – Adding any missing concepts to the integration model .....	8
Figure 7 – Identifying the subset of the integration model.....	8
Figure 8 – Creating the mapping between the integration model subset and the application model.....	9
Figure 9 – Standards organization .....	10
Figure 10 – Data consolidation.....	11

## Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75% of the member bodies casting a vote.

In other circumstances, particularly when there is an urgent market requirement for such documents, a technical committee may decide to publish other types of normative document:

- an ISO Publicly Available Specification (ISO/PAS) represents an agreement between technical experts in an ISO working group and is accepted for publication if it is approved by more than 50 % of the members of the parent committee casting a vote;
- an ISO Technical Specification (ISO/TS) represents an agreement between the members of a technical committee and is accepted for publication if it is approved by 2/3 of the members of the committee casting a vote.

An ISO/PAS or ISO/TS is reviewed every three years with a view to deciding whether it can be transformed into an International Standard. Attention is drawn to the possibility that some of the elements of this part of ISO 18876 may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO/TS 18876-1 was prepared by Technical Committee ISO/TC184, *Industrial automation systems and integration*, Subcommittee SC4, *Industrial data*.

This International Standard is organized as a series of parts, each published separately. The structure of this International Standard is described in this part of ISO 18876.

A complete list of parts of ISO 18876 is available from the Internet:

`<http://www.iso18876.org/parts.html>`

Annex A forms a normative part of this part of ISO 18876.

## 0 Introduction

### 0.1 Overview of ISO 18876

This International Standard establishes an architecture, a methodology, and other specifications for the integration of industrial data for exchange, access, and sharing. The objective is to provide the following capabilities:

- integrating data from different sources, different models, perhaps written in different modelling languages;
- sharing data among applications through systems integration architectures;
- resolving conflict between models developed with different objectives;
- translating data between different encodings and models between different modelling languages.

The components that support these capabilities include:

- integration models;
- methods for creating, extending, and updating integration models;
- methods for mapping between an integration model and an application model that falls within its scope;
- encoding and decoding of data and models with different formats, such as ISO 8876 (SGML), XML, ISO 10303-11 (EXPRESS), ISO 10303-21;
- methods for integrating data sets from different sources and different models including identification mechanisms;
- appropriate modelling and mapping languages.

### 0.2 Organization of this part of ISO 18876

The organization of this part of ISO 18876 is as follows:

- clause 1 specifies the scope and field of application of the International Standard and of this part of ISO 18876;
- clause 2 identifies additional standards that, through references in this part of ISO 18876, constitute provisions of this part of ISO 18876;
- clause 3 defines terms used in this part of ISO 18876;
- clause 4 describes the organization of this International Standard;
- clause 5 provides an overview of the integration process;
- clause 6 provides an overview of the processes of data mapping and consolidation;
- clause 7 summarizes the relationships with other standards.

### 0.3 Target Audience

The target audience for this part of ISO 18876 is technical managers wishing to determine whether ISO 18876 is appropriate for their business needs and implementers wishing to obtain an overview of its contents.



# Industrial automation systems and integration — Integration of industrial data for exchange, access, and sharing — Part 1: Architecture overview and description

## 1 Scope

This International Standard establishes an architecture, a methodology, and other specifications for the integration of industrial data that satisfy the following requirements:

- integrating data from different sources, different models, perhaps written in different modelling languages;
- sharing data among applications through systems integration architectures;
- resolving conflict between models developed with different objectives;
- translating data between different encodings and models between different modelling languages.

The following are within the scope of ISO 18876:

- integration models;
- methods for creating, extending, and updating integration models;
- methods for mapping between an integration model and an application model that falls within its scope;
- mechanisms for encoding and decoding of data and models with different formats;
- methods for integrating data sets from different sources and different models including identification mechanisms;
- modelling and mapping languages.

The following is within the scope of this part of ISO 18876:

- an outline of the architecture.

The following are outside the scope of this part of ISO 18876:

- detailed specifications of the elements of the architecture.

NOTE Such specifications can be found in other parts of ISO 18876 or in other standards.

## 2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of ISO 18876. For dated references, subsequent amendments to, or revisions of, any of these

publications do not apply. However, parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO/IEC 8824-1:1994, *Information technology — Open systems interconnection — Abstract syntax notation one (ASN.1) — Part 1: Specification of basic notation*.

ISO 10303-1:—<sup>1)</sup>, *Industrial automation systems and integration — Product data representation and exchange — Part 1: Overview and fundamental principles*.

ISO 10303-11:—<sup>2)</sup>, *Industrial automation systems and integration — Product data representation and exchange — Part 11: The EXPRESS language reference manual*.

Others to be added as required – I've assumed here that we will want to reference the second editions of Part 1 and Part 11 of STEP.

### 3 Terms and definitions

For the purposes of this part of ISO 18876, the following terms, definitions, and abbreviations apply; those taken from ISO 10303-1 are repeated below for convenience.

**NOTE** Definitions copied verbatim from other standards are followed by a reference to the standard in brackets, such as “[ISO 10303-1]”. In these cases the definition in the referenced document is normative; its repetition here is informative and in the case of any discrepancy the definition in the referenced document has precedence. An explanatory note follows definitions that have been adapted from other standards. In these cases the definition given here is normative for the purposes of this part of ISO 18876.

#### 3.1

##### **application model (AM)**

model that represents information used for some particular purpose

**NOTE** Some application models are also integration models.

#### 3.2

##### **class**

collection to which we attach some significance

#### 3.3

##### **concept{XE "concept" }**

general notion or idea of something

#### 3.4

##### **data**

representation of information in a formal manner suitable for communication, interpretation, or processing by human beings or computers

[ISO 10303-1]

#### 3.5

##### **data model**

definition, structure, and format of data

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<sup>1)</sup> To be published. (Revision of ISO 10303-1:1994)

<sup>2)</sup> To be published. (Revision of ISO 10303-11:1994)

**3.6****derived concept**

concept that is wholly defined in terms of primitive concepts (directly or indirectly)

**3.7****foundation concept**

concept that determines the underlying world viewpoint of an integration model

EXAMPLE The concepts of “class” and “individual” are foundation concepts for a general integration model.

**3.8 general concept**

concept that has very wide applicability, but is a subclass of some foundation concept

NOTE the boundary between what is a foundation concept and what is a general concept is fuzzy.

**3.9****individual**

thing that is a possible extension in space-time

**3.10****information**

facts, concepts, or instructions

[ISO 10303-1]

**3.11****integration model (IM)**

application model that is capable of integrating other application models

**3.12****model**

limited representation of something suitable for some purpose

**3.13****model context**

range of activities for which a model is valid

**3.14****model scope**

range of information that a model can describe

**3.15****primitive concept**

concept in an integration model that cannot be defined in terms of other concepts

**3.16****specific concept**

concept that is a subclass of some general concept (directly or indirectly) with a limited range of applicability

EXAMPLE Car, process plant, quark, purchase order, and XML document are examples of specific concepts.

NOTE the boundary between what is a general concept and what is a specific concept is fuzzy.

## 4 Organization of ISO 18876

ISO 18876 is divided into a number of parts.

ISO 18876-1 (this part) provides an overview and specifies an architecture for the integration of industrial data.

ISO 18876-2 specifies methods for integrating application models and for developing and extending integration models.

NOTE Other specifications may be developed to extend the capability of ISO 18876, such as:

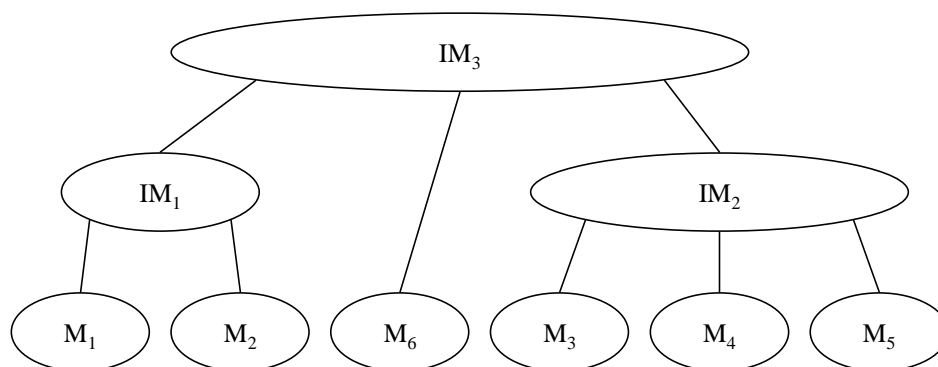
- models designed to integrate two or more other models;
- models designed to meet the needs of a particular application (application models);
- mapping specifications designed to specify how a population of one model may be migrated to another model;
- methods and languages to support the definition of models and mappings between different modelling languages;
- methods and specifications for the encoding of models, and translation between encodings;
- the specification of services and interfaces to be provided by conforming implementations.

## 5 Model integration

### 5.1 Integration models

#### 5.1.1 Principles

The three-layer architecture for data models [1] shows that for any data model it is possible to construct views on it that are subsets of the original model; these subsets may be constrained. In this International Standard this principle is extended to cover other types of model and modelling language. In the integration of models this process is reversed: a model is created of which the initial models are subsets or constrained subsets. A model created in this way is an integration model with respect to the initial models in that it is capable of representing information with the scope of either or both of the original models. This is illustrated in Figure 1 below.



**Figure 1 – Model Integration**

This approach works if such an integration model can be created. An integration model can be created if the aspects of the world that are modelled are subject to a single order that is understood [2].

NOTE 1 Difficulties in creating such a model point to a gap in human knowledge about that order (or the lack of an order).

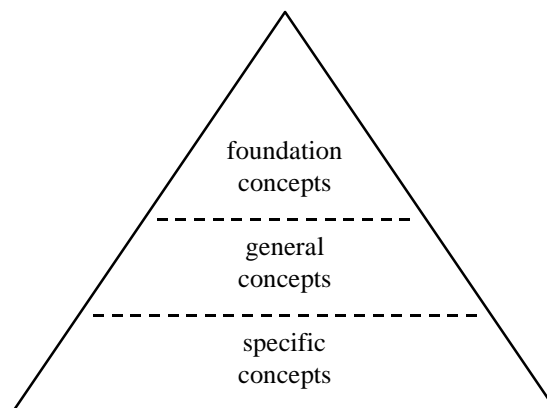
NOTE 2 Models that have been created as integration models can themselves be integrated. This means that any arbitrary set of models can, in principle, be integrated at the cost of creating a new model; this is supported by the architecture defined in this standard.

NOTE 3 One possible objective for use of the architecture defined here is the development of an integration model that is stable in the face of new models that are being integrated. Here stable means that the existing model does not need to be changed as more models are integrated, though extensions may be necessary.

Integration models will contain concepts that are more generic than the models they integrate. This is necessarily the case when the models being integrated have conflicting constraints affecting the information that is to be represented. However, the constraints should be held in some other form, rather than in the structure of the model.

### 5.1.2 Integration model concepts

An integration model represents concepts such as classes and individuals. These concepts can be classified as primitive concepts (see 3.15) and derived concepts (see 3.6). Primitive concepts are the building blocks for the definition of other concepts, and can be further classified as foundation concepts (see 3.7), general concepts (see 0), or specific concepts (see 3.16) as represented in Figure 2 below.



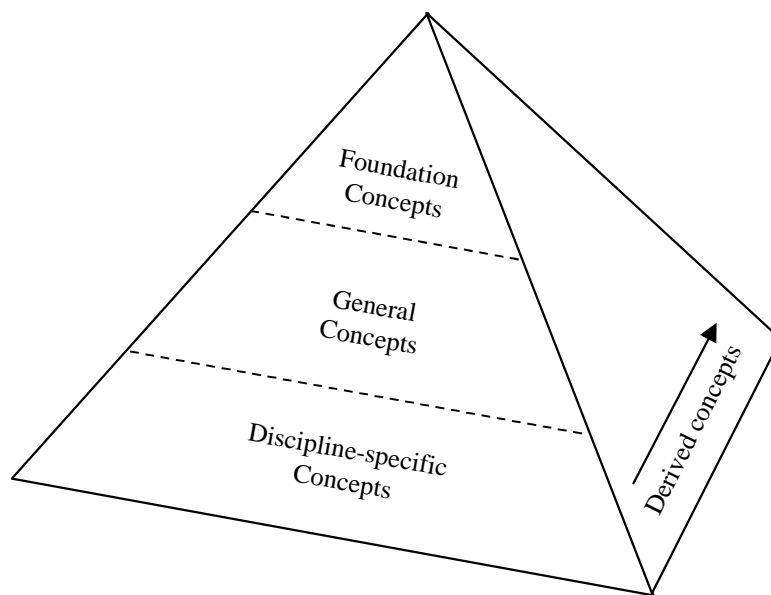
**Figure 2 – Primitive Concepts**

NOTE Specific concepts are dependent on general concepts that are dependent on foundation concepts, since the lower concept relies on the existence of one or more higher level concepts. For example, without the concept of classification, there is relatively little that can be said about anything.

EXAMPLE 1 An overall integration model might have top level foundation concepts like classification, connection and composition. At the next level, it might have general concepts like those of physics, and finally discipline specific concepts that are limited in their range of application.

### 5.1.3 A Full Integration Model

A full integration model, as illustrated in Figure 3, is more than just primitive concepts; it includes derived concepts – useful and valid combinations of primitive concepts. Only derived concepts that are of interest need be recorded.

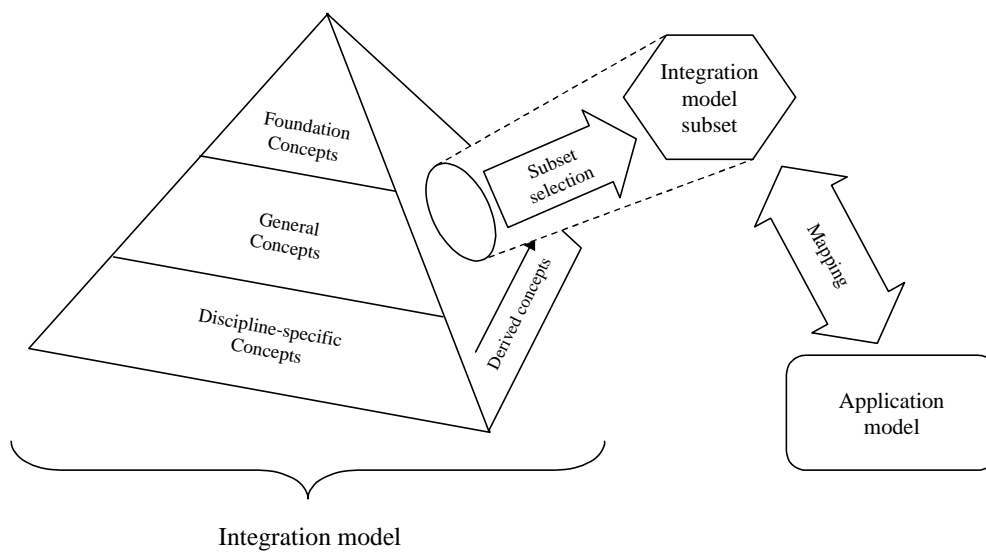


**Figure 3 – A full integration model**

This architecture does not require that primitive concepts are primitive for ever. If a concept that is initially thought to be a primitive concept turns out not to be, then the concepts it is derived from can be added, and the derivation added, so that it becomes a derived concept away from the front face of the pyramid. This allows flexibility to reflect improved knowledge of the world, rather than being fixed and constrained by knowledge at a point in time. Therefore an integration model will need to be maintained and extended, and a mechanism for maintenance and extension will be necessary.

## 5.2 Overview of the integration process

Integrating an application model with an integration model is illustrated in Figure 4 below. The goal of this integration process is to allow the same information to be represented in the application model or in the integration model without loss of meaning, and to allow transformations between these representations. The result of the integration process is a mapping between the application model and a subset of the integration model. In order to define this mapping it may be necessary to extend the integration model so that it precisely represents the concepts found in the application model.



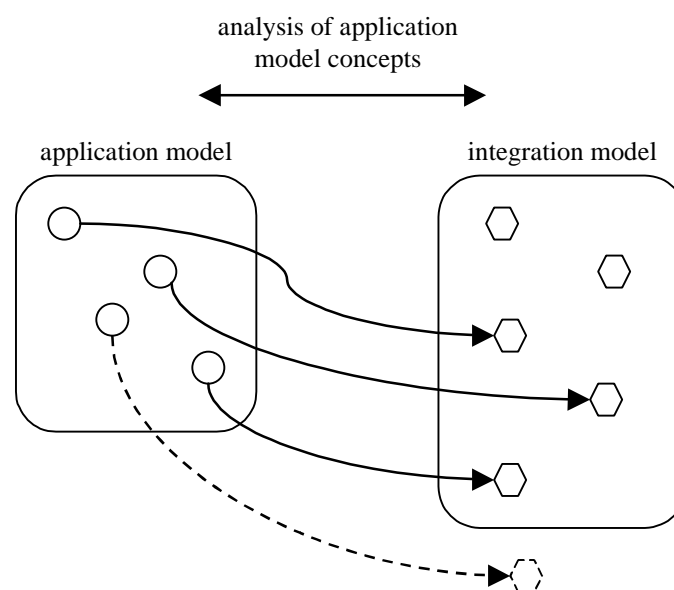
**Figure 4 – Integrating and application model with an integration model**

Being an integration model derives from the role that it plays with respect to other application models. The fundamental characteristic of an integration model is that it integrates two or more application models.

The process of integrating an application model with an integration model is divided into a number of steps, as follows:

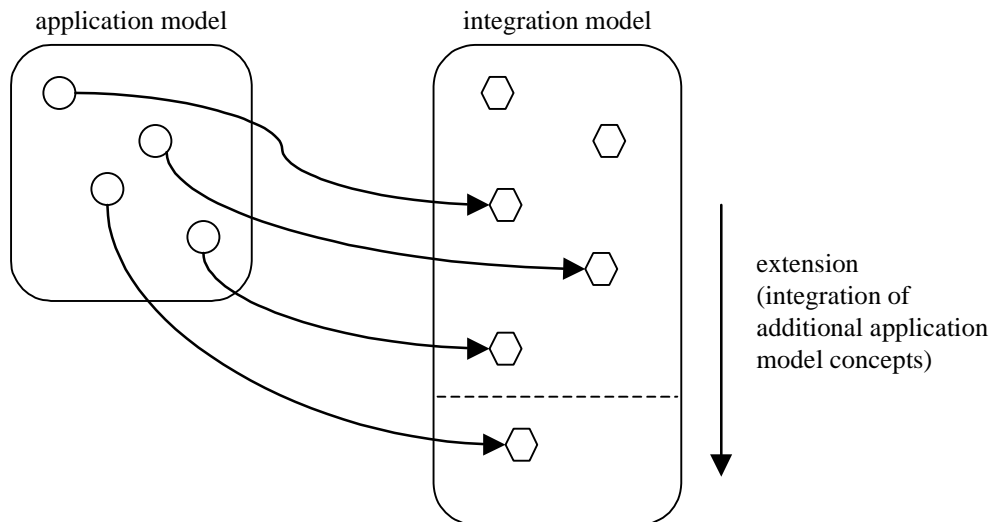
- analyse the application model and identify the equivalent concept of the integration model, including any constraints that apply (see Figure 5);

**NOTE** Complete integration requires that both explicit and implicit data is mapped into the integration model. Most application models have a context within which the model has to be understood, but which is not explicit in the model itself.



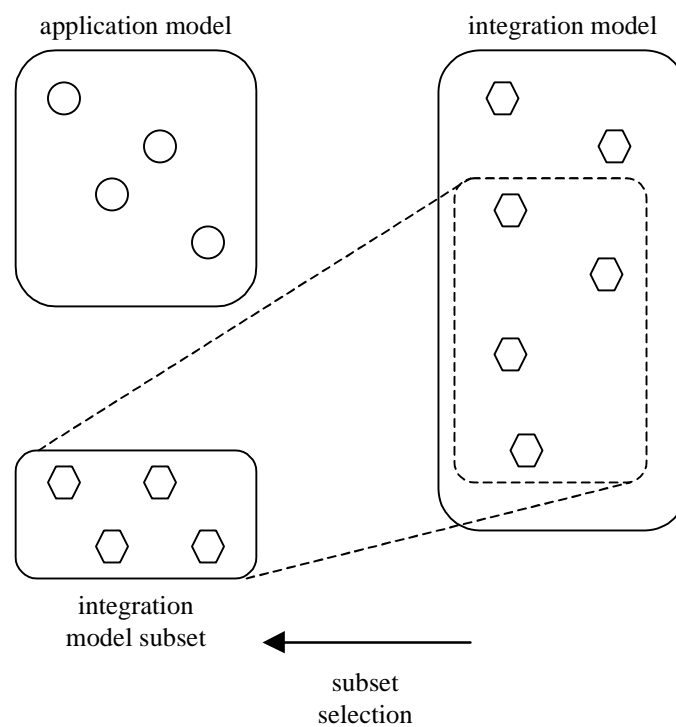
**Figure 5 – Analyzing the application model**

- if necessary, extend the integration model so that it includes all the concepts found in the application model (see Figure 6);



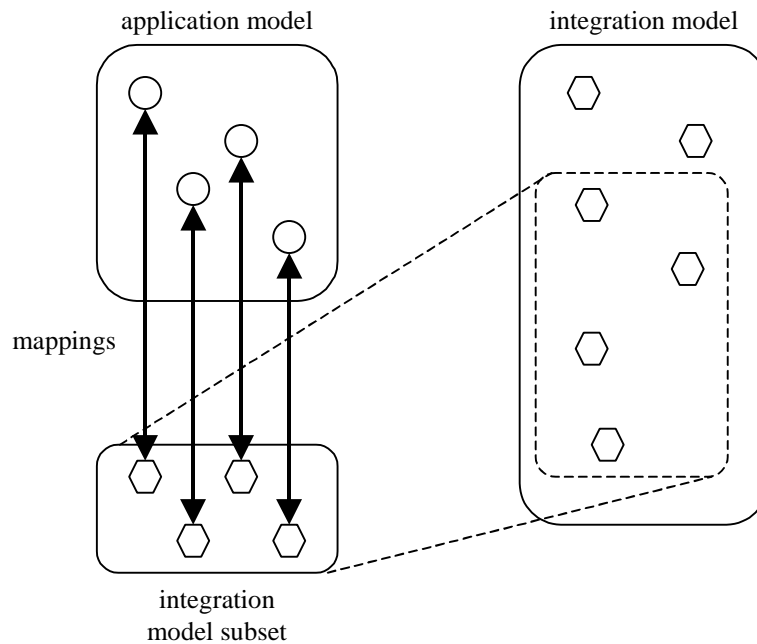
**Figure 6 – Adding any missing concepts to the integration model**

- identify the subset of the integration model that represents the concepts in the application model (see Figure 7);



**Figure 7 – Identifying the subset of the integration model**

- create the mapping in each direction between the application model and the subset of the integration model (see Figure 8);



**Figure 8 – Creating the mapping between the integration model subset and the application model**

- specify any structural transformations, terminology transformations, or encoding transformations that apply within the mapping;
- specify any translations that are necessary between model representations;

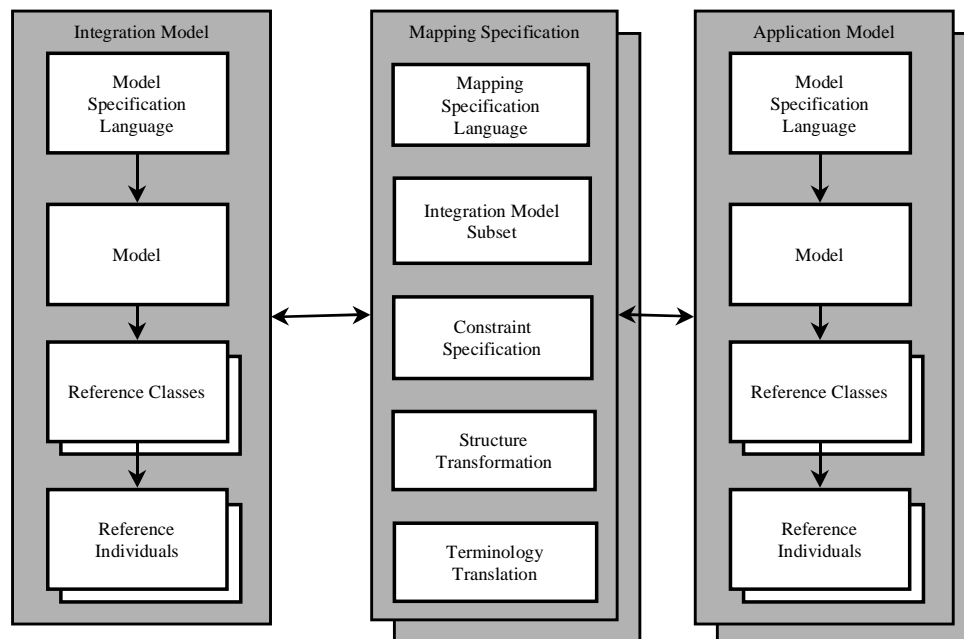
**EXAMPLE 1** If an application model is specified in the XML Schema definition language and the integration model to which it is mapped is specified in EXPRESS (ISO 10303-11), a translation between these languages will be necessary to map between different representations of the same concepts.

- if there are two or more application models that are to be integrated, repeat this process for the other application models.

Mapping successfully in both directions requires that both the explicit and implicit data are mapped into the integration model. Most application models have a context within which the model has to be understood, but which is not explicit in the model itself.

**EXAMPLE 2** A salary payment system has an entity data type called **employee**, yet it is implicit that each person represented by instances of this entity data type is an employee of the company that operates the system.

## 6 Integration architecture components



**Figure 1 – Integration architecture components**

Figure 1 gives an alternative view of Figure 4 showing the elements that may be standardized, as follows:

- integration models;

NOTE 1 This may be a single model with multiple levels of abstraction, using a suitable logic based language or a layered model, using an entity-relationship language such as EXPRESS with e.g. a data model and reference data libraries. Figure 1 illustrates the use of a model to define the structure of a reference data library that can hold reference classes and reference individuals.

NOTE 2 There may be a number of reference data libraries. These are to cover the discipline specific primitive concepts, and the rest of the interior of the pyramid. Procedures are required for their development to ensure there is no duplication across the libraries.

NOTE 3 Standard individuals may be defined as well as standard classes.

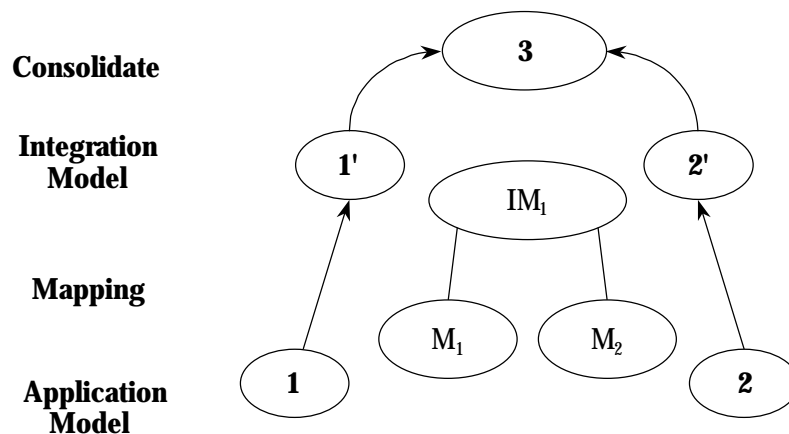
- mapping specifications that specify a subset of the integration model, constraints that specify the population of the integration model that maps to the application model, structure transformations between the structure of the integration model and the structure of the application model, and finally terminology translations between the integration model and an application model;

NOTE 4 Mapping specifications may also be required between model specification languages.

- application models.

## 7 Data mapping and consolidation

Mapping between models is not sufficient to achieve integration. This requires reconciliation of information represented according to the different models. This process is illustrated in Figure 2 below.



**Figure 2 – Data consolidation**

- Translate the data population 1, and 2, according to their source models into the data populations 1' and 2' according to the model IM<sub>1</sub>.
- Identify which data elements in the two data sets represent the same things, and eliminate redundancy.

**NOTE** This requires a reliable identification mechanism that is used by, or for which there is a mapping from, the two models M<sub>1</sub> and M<sub>2</sub>. However, an identification mechanism does not necessarily mean setting up some new identifier for use by the various systems. In practice, there are often existing identifiers that can be used, as well as collections of attributes that can provide unique identification.

## 8 Relationship to other standards

This International Standard can be used in conjunction with other standards. It can be used by a standard that specifies a set of integrated models in some particular area to create that integration by design.

**EXAMPLE 1** ISO 15926 specifies a data model and a reference data model that together form an integration model for process industry applications.

This International Standard can also be used to integrate existing information standards where integration is desired but was not achieved by design.

**EXAMPLE 2** The methodology described in ISO 18876-2 can be used to integrate a product data exchange capability specified in an ISO 10303 application protocol and a document exchange capability described by an XML Document Type Declaration.

## **Annex A**

### **(normative)**

## **Information object registration**

To provide for unambiguous identification of an information object in an open system, the object identifier

`{iso standard 18876 part{1} version {1}}`

is assigned to this part of ISO 19976. The meaning of this value is defined in ISO/IEC 8824-1, and is described in ISO 10303-1.

**NOTE** This is the object identifier that will apply to the published (IS) version of this part of ISO 18876.

The reference to Part 1 of STEP assumes that the second edition of Part 1 defines usage of ASN.1 identifiers that is not limited to ISO 10303.

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## Index

application model .....	2
class .....	2
data .....	2
data model .....	3
derived concept.....	3
foundation concept.....	3
general concept.....	3
individual .....	3
information .....	3
information object registration.....	12
integration model .....	3
model .....	3
model context .....	3
model scope.....	3
primitive concept .....	3
specific concept .....	3